

SYNTHESIS PAPER

Creating Cleaner Cities: Policy Options for Solid Waste Management

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1. Executive summary

Waste is an inevitable by-product of socio-economic activity. Everyday actions such as cooking and cleaning, and economic tasks such as construction and transport, all generate waste. In low- and middle-income cities, rising incomes and rapid urbanisation are driving waste volumes to unprecedented levels—forecast to grow by 70% globally within three decades.¹ Without effective systems, the results are visible in dirty streets, blocked drains, and poor air quality, undermining both public health and municipal credibility.

As incomes rise, waste becomes not only more abundant but harder to manage—organic matter gives way to plastics and chemicals, raising operating costs and health risks. The challenge becomes acute in lower-income cities, where solid waste management (SWM) remains largely informal. In Kigali, Rwanda, many among the poorest 20% report dumping or throwing waste due to a lack of nearby services.²

The costs of neglect are high: toxins from dumping or open burning are linked to millions of premature deaths³, blocked drains from uncollected waste can worsen flooding more than underinvestment in storm drains, and landfill methane warms the planet 84 times faster than CO₂. Conversely, cleaner air raises productivity: reductions in pollution cut absenteeism and increase output.⁴

SWM is therefore a core municipal service and a visible public good. In developing-country cities, it typically absorbs around 20% of municipal budgets, making it one of the largest recurring expenditures.⁵ Because unmanaged waste is highly visible, it also becomes a direct measure of government competence. Even modest, credible improvements—such as placing public bins in Kabul, Afghanistan—have strengthened municipal legitimacy and increased citizens' willingness to pay service fees and follow disposal rules.⁶

Experience from cities worldwide offers clear lessons on delivering effective solid waste management. Technology choices must fit local realities: household waste storage may suit planned areas but is costly in dense, informal settlements, where well-sited communal points for waste storage can improve access and reduce roadside dumping. Since collection and transport absorb most waste budgets, efficiency matters—transfer stations can cut haulage distances, and combining

1 Hoornweg, D., & Bhada-Tata, P. (2012). What a waste: a global review of solid waste management.

2 Rajashekar, A., & Bowers, A. (2019). Assessing waste management services in Kigali. *International Growth Centre, Policy Brief*.

3 WHO. (2024). WHO launches directory of resources for planning healthy environments.

4 Hanna, R and Oliva, P (2015). The effect of pollution on labor supply: Evidence from a natural experiment in Mexico City. *Journal of Public Economics*. 122. p68-79

5 Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. (2018). *What a waste 2.0: a global snapshot of solid waste management to 2050*. The World Bank.

6 Harman, O., Karim, F., Rahim, S., & Wani, S. (2020). Urbanisation in fragile societies: thinking about Kabul. *International Growth Centre Blog*.

large trucks with smaller, maneuverable carts extends service into hard-to-reach areas.

Decisions on who delivers waste services must balance the mix of public, private and informal provision. Centralised public systems suit high-fixed-cost functions such as trunk collection and disposal, while decentralised community-led models can work well for organics and reusables. Private companies and PPPs can bring capital, expertise, and efficiency, but risk cost-cutting and inequitable coverage without strong regulation, clear contracts, and robust monitoring. The informal sector is an underused asset—waste pickers already provide low-cost recovery and last-mile coverage, and integrating them into formal systems improves both livelihoods and efficiency.

Improving compliance in waste management requires both enforcement and trust-building. Sanctions—such as fines for illegal dumping, littering, or open burning—are most effective when clear, consistently applied, and supported by municipal capacity to monitor violations. Yet enforcement alone rarely sustains behaviour change. Public awareness campaigns, visible improvements in service, and predictable, reliable collection schedules reduce the effort for households to comply and foster a sense of reciprocity with the municipality. Over time, these measures can shift social norms, making responsible disposal the default.

Sustainable waste management depends on secure, politically-viable funding streams. Cities can draw on household charges—whether flat rates or usage-based fees—non-household levies, gate fees at disposal sites, or allocations from existing taxes. The design must balance cost recovery with affordability, adapting to local administrative capacity and income levels. Simpler systems suit lower-capacity contexts, while more complex, usage-linked pricing can be effective where billing and monitoring systems are strong. Public willingness to pay rises when fees are transparently linked to visible service improvements, making it critical to sequence reforms such that early investments deliver clear, tangible benefits.

Overall, more complex systems—such as source segregation, unit-based pricing (“pay as you throw”), or differential charges for different waste types—can improve recycling rates, reduce landfill use, and create markets for waste. However, these systems demand higher administrative capacity, reliable monitoring, and strong public trust. In contexts where municipal enforcement is weak or services are unreliable, they can unintentionally incentivise illegal dumping or burning, as households seek to avoid the extra effort or cost.

The more complex and costly the system for the user, the stronger the risk that waste will leak out of the formal system. Cities therefore need to sequence reforms—starting with service reliability, visible benefits, and simple, affordable payment structures—before layering on more complex mechanisms.



In this paper

In this paper we focus on policy options for providing SWM services in low- and middle-income cities. **Section 1** covers technologies for storage, collection and transport, and diversion or disposal. **Section 2** addresses who provides services and how to integrate informal actors. **Section 3** sets out compliance options—sanctions, awareness, building trust, and changing social norms. **Section 4** discusses funding—existing taxes, flat charges, unit pricing, and gate fees—and how to adapt them to local capacity.

2. Deciding between technologies for efficient waste management systems

When implementing an effective solid waste management system, policymakers must decide how refuse will be stored, collected, transported, and diverted or disposed. While the precise technologies for managing and disposing of waste are constantly changing, the policy decisions remain stable: balancing financial, administrative and environmental trade-offs across models.

Storage

Waste is first stored at the household or community level. This choice sets the unit cost and access pattern for collection. Given the convenience benefits, **storage at the household level** is typically the preferred option in developed countries with well-developed waste management systems. Yet household storage raises **routing costs**, because coverage must reach every dwelling. It can also sometimes be infeasible in contexts where households are inaccessible, or administratively burdensome to access—such as in dense and informal neighbourhoods.

Storage at the community level can be a useful alternative in such contexts. The challenge is identifying communal storage areas that are convenient both to robust and regular municipal collection schedules, as well as to drop-offs by nearby residents. For example, in Mekelle, Ethiopia, inadequate supply of waste containers and long distances to them increased the probability of roadside waste dumping: a 1% increase in distance saw a 0.5% increase in probability of unauthorised disposal.⁷ Another challenge is choosing the right site, as some citizens will bear a greater burden of the potential health and pollution consequences of residing near waste storage facilities.

Cities in low- and middle-income countries are likely to have a combination of both storage types depending on neighbourhood density and socio-economic conditions. Where access is limited, communal points and transfer stations are more feasible; where plots are accessible, household storage supports higher frequency at higher per-route cost.

Collection and transportation

Collection and transportation involve gathering waste from households and communal collection points to a common point and then sending waste to the final disposal area. This stage is typically the largest cost centre, driven by capital investments in vehicles, and ongoing fuel, maintenance, and labour costs.

As cities grow and land values increase, disposal sites tend to move further away from the city centre, costing more to transport. For

⁷ Tadesse, T., Ruijs, A., & Hagos, F. (2008). Household waste disposal in Mekelle city, Northern Ethiopia. *Waste Management*, 28(10), 2003-2012.

example in Hambantota, Sri Lanka it is 3km from centre, while in growing cities such as Kampala, Uganda, this distance increases up to 13km,⁸ and in larger cities, such as Beijing, this distance is up to 50km.⁹

However, landfills represent large, fixed investments, and sometimes these disposal sites are not moved as the city grows. For example, Kampala currently only has one landfill, Kiteezi, established in 1996. Prior to its construction, the only designated dump was Wakaliga, 6km from the city centre. Both sites took up valuable city space beyond their efficient and safe use. With Kiteezi reaching capacity in 2012, its continued use combined with erratic weather resulted in a deadly landslide in 2024. Now, new landfills are being built in Dundu, 33km outside of the centre. In all cases, the use of smaller secondary transfer stations can be effective in managing transport flows, with transfer stations converting long hauls into fewer trunk trips, smoothing fleet utilisation and lowering operational costs.

The **type of vehicles** used in transportation impacts which neighbourhoods and which waste storage facilities they will be able to access. Expensive, larger vehicles are often used by municipalities or contracted private companies, but they are often only suitable for planned parts of the city, and are not able to access densely-populated, informal areas. Instead, inexpensive vehicles like hand carts used by informal collectors are often more viable options in smaller cities or dense informal settlements with narrow streets. This leaves informal areas often underserved by the government.

Efficient waste transportation methods should therefore use a combination of different vehicles and different actors - balancing their fleet of vehicles based on factors such as their road network, service areas, and cost to ensure service continuity.

Decisions on the **collection frequency** should consider the trade-offs between convenience for citizens with the cost required for frequent collection. Waste volumes, climate, citizen expectations, urban density, and municipal capacity all factor into the ideal waste collection frequency, which varies widely between municipalities. A successful collection system also depends on the **predictability and certainty** of the waste collection, such that households can rely on their waste being collected on certain days and depositing it accordingly. Such predictable schedules reduce **household transaction costs** and raise **compliance**, even at moderate frequencies.

Collection design determines the quality and quantity of materials available for diversion. **Segregation at source** and reliable pick-up raise recovered value and reduce contamination, shifting the balance towards higher-value diversion options.

8 Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. *Sustainability*, 11(19), 5523.

9 Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1), 220-232.

Diversion or disposal

Diversion or disposal is the last stage in the process of solid waste treatment, diversion **retains value** while disposal **incurs cost** and environmental or health externalities. They include the following commonly used methods:

Waste diversion

- Recycling
- Composting
- Waste to energy (controlled incineration and biofuel)

Waste disposal:

- Landfills
- Open burning

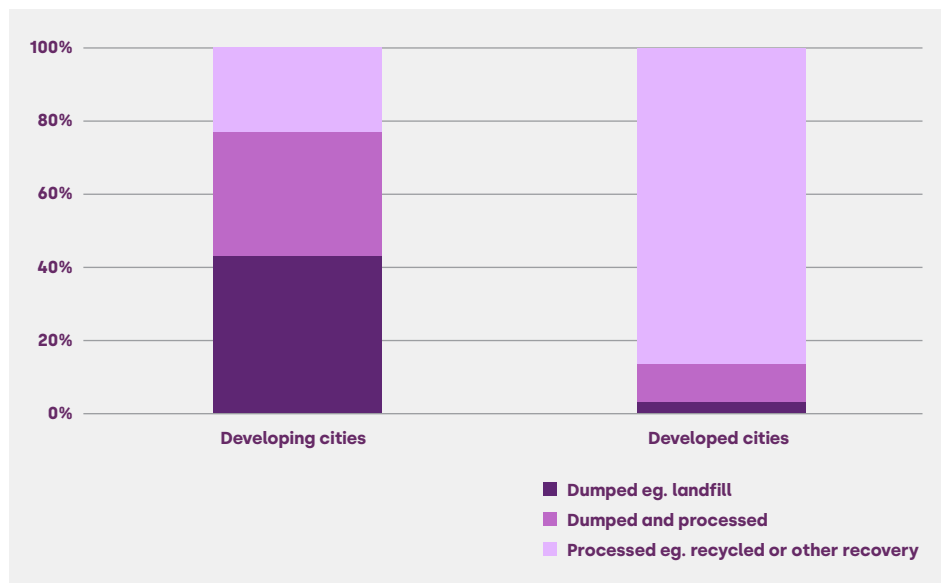
According to the hierarchy of waste management, recycling has the highest value retained and is more environmentally beneficial compared to landfills and open burning (see **Figure 1**). However, higher value retention also requires higher levels of capacity, and is more costly to deliver. Moving down the hierarchy indicates less favourable end uses for waste, but also processes that are simpler and more accessible for residents and municipalities. **Appendix 1** summarises the various diversion and disposal options available and their trade-offs in terms of environmental, health, and economic impacts, as well as municipal capacity.



Low-income citizens often reuse, repair, or remanufacture waste through necessity. Public policy can help formalise these innovative circular economy practices

As might be expected, **Figure 2** shows that developed cities predominantly process and recycle waste, while dumping and unsanitary landfills remain the mainstay of waste disposal in developing countries. However, 'circular economy' approaches are gaining traction, with initiatives to generate value and create jobs by diverting and re-using waste.

Figure 1: Waste disposal type in developing and developed cities¹⁰



Note: Data from 103 cities covering 57 countries

Low-income citizens often reuse, repair, or remanufacture waste through necessity.¹¹ But these activities only take place at the household level, with limited commercial centre engagement.¹² To improve value maximisation from existing resources, public policy can help cities formalise these innovative practices.

Recycling has the highest value retained and is more environmentally beneficial than landfills and open burning. However, higher value retention also requires higher levels of capacity, and is more costly to deliver.

One initiative currently being piloted uses plastic waste for the construction of homes in Kenya, Cameroon, and Senegal. Using 75% of local plastic waste as a raw material and transforming into modular construction materials with local labour, eight tonnes of plastic can create a four storey, 60 metre-square building. This can be delivered rapidly with on production line producing 2,800 housing units annually.¹³ With plastics losing 95% of their value as a material after a single use,¹⁴ reusing them as a lower-value input also aligns with their new economic worth.

¹⁰ Banerjee, S., & Sarkhel, P. (2020). Municipal solid waste management, household and local government participation: a cross country analysis. *Journal of Environmental Planning and Management*, 63(2), 210-235.

¹¹ Stahel, W. R. (2016). The circular economy. *Nature*.

¹² Aryampa, S., Maheshwari, B., Sabiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. *Sustainability*, 11(19), 5523.

¹³ UN-Habitat. (2020). UN-Habitat aims to use plastic waste to support housing for all

¹⁴ World Economic Forum, Ellen MacArthur Foundation and McKinsey & Company. (2016). *The New Plastics Economy: Rethinking the future of plastics*. World Economic Forum.

Another example of proactive public policy can be observed in a reuse initiative in Taiwan. The Environmental Protection Administration collaborated with the Ministry of Economic Affairs to promote 43 items for reuse. The governments engaged with major industrial waste producers to repurpose these items, which ranged from scrap paper—reused as pulp—to tobacco leaf—reused as fertiliser.¹⁵ The programme now provides both technical assistance and financial incentives, for example, tax reduction for investment or lower-interest loans, to enhance resource reuse. Between 1987 and 2001, over 300,000 tonnes of waste was successfully exchanged—approximately the same volume of waste as Nairobi generates in 150 days.

Waste-to-energy is another area of growing interest that reduces waste, while also reducing reliance on fossil fuels. Bankability depends on feedstock risk, emissions control, and a creditworthy off-taker under a transparent tariff. **Box 1** below describes the Al Ghabawi plant in Amman. Achieving these circular economy objectives requires proper segregation to be viable, the involvement of private actors, and incentives to promote compliance.

Case study 1: Waste to Energy – Amman, Jordan¹⁶

Population increases linked to the Syrian Refugee Crisis and strains on municipal infrastructure have led to increased challenges to Jordan's SWM system. In 2015, the Greater Amman Municipality acquired funding from the World Bank and the European Bank for Reconstruction and Development to improve and extend the Al Ghabawi landfill in Jordan, with the objective of improving its **biogas collection system** and creating a Landfill Gas Recovery system. By collecting biogas and using it for power plant generation, rather than flaring emissions, the project aimed to produce electricity for the national power grid.

Designed, built, and operated through a **public-private partnership**, the Landfill Gas Recovery system at the Al Ghabawi landfill has helped generate energy for Amman and nearby municipalities. As of the commissioning of the Gas-to-Energy plant, approximately **106 MWh** were generated per day, with a capacity of **4.68 MW**. National recycling campaigns have also aided the biogas energy project, as **segregation at the source** is essential to separate organic waste, which decays and can be made into biogas, and non-organic waste that can be used. By improving waste segregation, the municipality is now working on pilot projects that would extend the life of the Al Ghabawi landfill, and its capacity to effectively generate energy.

¹⁵ Tsai, W. T., & Chou, Y. H. (2006). An overview of renewable energy utilization from municipal solid waste (MSW) incineration in Taiwan. *Renewable and Sustainable Energy Reviews*, 10(5), 491-502.

¹⁶ Greater Amman Municipality. (2022). *Ghabawi Municipal solid Waste Management Landfill Project*. Hamdallah, D. (2018, 2025-07-08). How Amman will use green tech to transform waste management. Abdeljawad, N., & Nagy, I. (2022). Waste-to-Energy (WTE) Projects as a Secondary Source of Renewable Energy for Urban Sustainability of Amman. *International Journal of Mechanical Engineering*.

Who should provide waste management services?

When designing the governance and provision of waste management services, municipalities must first decide the extent to which these services will be centralised at the municipal level or decentralised to the citizens. SWM exhibits natural monopoly characteristics in trunk collection and disposal, favouring centralisation, but decentralised models can suit management of organics, where community effort substitutes for municipal spend.

In a centralised model, the municipal authority controls the major share of responsibility, and requires high municipal financial and administrative investment. These models rely less on proactive waste management by citizens, but do require incentivising citizens to bring waste into the formal system rather than disposing of it informally.

Decentralised models involve the municipality encouraging its communities to manage their waste in their own neighbourhood. This model requires lower municipal expense, but relies on proactive engagement and ownership by the community. It is also usually limited to organic or re-usable materials, which can be treated through composting and recycling.

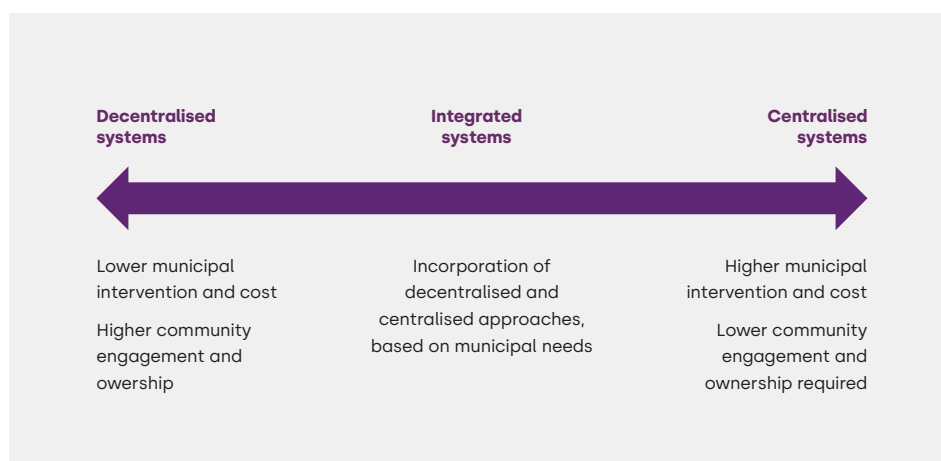
In practice, most waste management systems combine elements of both. This allocates high fixed-cost functions to the centre and low fixed-cost functions to neighbourhoods. The municipality makes an informed choice about the areas of operation and the type of waste to treat at the central facility, leaving some waste to be managed by people in a decentralised manner.



Integrated waste disposal models combine the efficiencies of central coordination while tailoring systems to local needs.

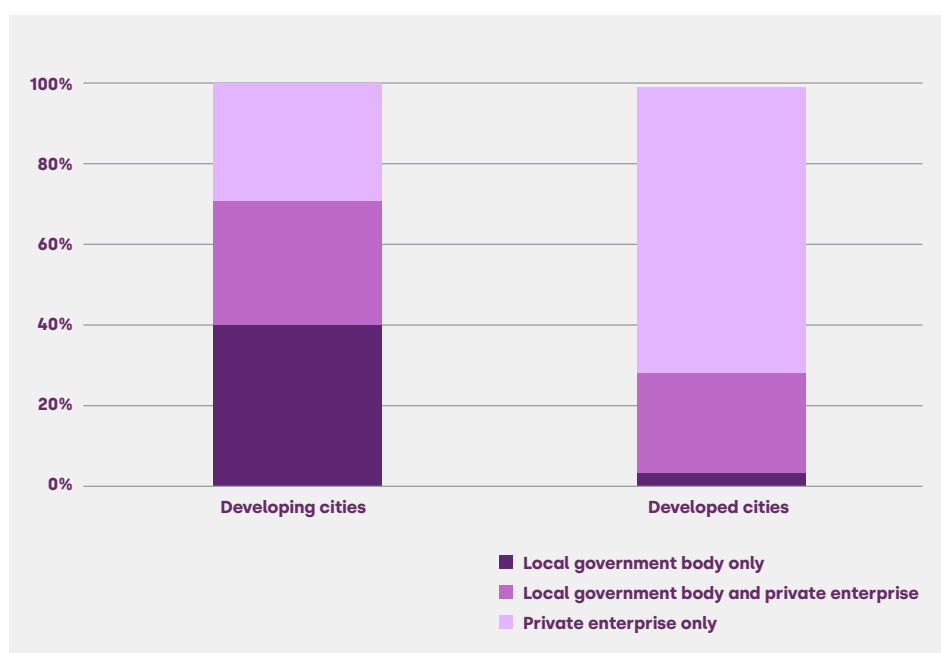
For instance, a city can choose to collect all the inorganic waste for processing in its centralised landfill, with people treating organic waste in decentralised composting hubs in their neighbourhoods. Integrated waste disposal models therefore combine the efficiencies of central coordination while still tailoring SWM systems to local needs and circumstances.

Figure 2: Decentralised to centralised systems



Furthermore, while municipal and national governments are responsible for creating the regulations and guidelines, the delivery of SWM services can be entirely public, contracted to private providers, or involve some kind of partnership between both. As with disposal, who provides these services differs in developing and developed countries. The former rely primarily on government and PPPs, and in the latter they are largely provided privately. This is shown in the figure below.

Figure 3: Waste service provision in developing and developed cities¹⁷



Note: Data from 103 cities covering 57 countries

¹⁷ Banerjee, S., & Sarkhel, P. (2020). Municipal solid waste management, household and local government participation: a cross country analysis. *Journal of Environmental Planning and Management*, 63(2), 210-235.

Regardless of who is delivering them, comprehensive SWM services will always rely on some level of public subsidy and management.

It is worth noting that, regardless of who is delivering the services, comprehensive SWM services will always rely on some level of public subsidy and management. As with other utilities, the provision of SWM services is a natural monopoly. That is, the start-up investments and barriers to entry are so high that it prevents a competitive private market from forming. Furthermore, the public harms caused by poor waste management strongly justify public subsidisation to improve overall welfare in the city.

At the same time, even where municipal waste services are fully provided by the government, there will always be some level of private actor involvement. This could be through the contributions of informal waste collectors and pickers, or formal companies that are able to extract value somewhere along the SWM value chain. The policy options are therefore not about whether to include private actors, but rather to what extent municipalities require and make use of their participation, or simply create an enabling environment for them to flourish.

Private companies and public private partnerships in urban solid waste disposal

In cities in developed countries, over 90% of SWM systems are completely or partly run with private participation.¹⁸ Municipalities often **contract a private company** to outsourcing elements of the SWM process. For instance, cities can engage companies to assist them with waste collection and transportation services, thereby avoiding having to pay for costly municipal vehicle fleets.

In Dar es Salaam, the inclusion of private actors is suggested to have improved collection from 10% in 1994 to 40% in 2001.

This approach allows municipalities to provide SWM services without needing to invest in new municipal resources or hire more public sector employees. In Dar es Salaam, Tanzania, the inclusion of private actors is suggested to have improved collection from 10% in 1994 to 40% of total waste generated in 2001.¹⁹

Beyond specific contracting, **public-private partnerships** (PPP's) are also harnessed where municipalities do not have the necessary capacity, or want to offset some of the maintenance burdens of the municipal fleet. PPPs allow cities to leverage private sector finances and expertise to deliver public services. Compared to outsourcing

¹⁸ Ibid.

¹⁹ Kaseva, M. E., & Mbuligwe, S. E. (2005). Appraisal of solid waste collection following private sector involvement in Dar es Salaam city, Tanzania. *Habitat international*, 29(2), 353-366.

SWM services, PPPs involve deeper public engagement through jointly delivered services, rather than simply paying for the services of a SWM company. City governments play a role in structuring the project and its timeline. They are responsible for any risks associated with bringing a private sector partner into a SWM partnership.

In solid waste management, PPPs can offer several key benefits:

- ✓ **Incentives to reduce cost and deliver on time**—the motivation to be profitable and reach contractual goals can reduce costs and lead to better service delivery.
- ✓ **Private sector expertise and efficiency**—with experienced private companies, cities can utilise private sector knowhow to better implement SWM systems. This allows cities to benefit from guidance and additional support in implementing efficient systems.
- ✓ **Provision of up-front capital**—PPPs can allow cash-strapped governments to utilise private capital. This allows municipalities to overcome short-term credit constraints to ensure that waste management services are provided. However, it is important to remember that this may not reduce the overall cost to the government—they might still need to subsidise services and consider income generated from user-fees.

However, PPPs can also create additional challenges when managing waste:

- ✗ **Cost minimisation is promoted ahead of overall welfare.** Given that private firm decisions are largely driven by profit, this may result in efforts to minimise costs at the expense of quality, service coverage, or sustainability. For example, private sector actors may be less motivated to collect lower-value waste from low-income areas and harder-to-navigate informal settlements.
- ✗ **Access to finance can be more expensive.** Capital costs are, on average, almost 25% higher than direct public procurement due to private financing costs and project premiums required for taking on risk.²⁰ Furthermore, PPPs are eventually paid through government transfers, or through forgone revenues from user fees (that will be collected by private partners). Consequently, PPPs cannot solve budgetary constraints or borrowing challenges.
- ✗ **Creates opportunities for corruption.** Private providers can pay off local officials to gain preferential access to contracts through procurement processes without appropriate safeguards.

²⁰ Siemiatycki, M. (2019). Strategies for effective procurement and public-private partnerships in the transport sector. *IGC Policy Paper*.

- ✗ **Contracting and monitoring can be complicated.** PPPs require a high degree of public capacity to effectively design, negotiate, and to monitor the performance of the private party. As a natural monopoly, governments need to ensure utilities remain competitive and do not become extractive. This becomes even more complicated when determining optimal subsidies, since obtaining accurate cost information may be complicated. Many city governments – particularly in low-income countries – may face challenges in designing effective and enforceable agreements.
- ✗ **Requires coordination with other municipal infrastructure and services.** In the long term, planning and management of municipal waste management requires government involvement to ensure its alignment with public needs and other municipal infrastructure and services.
- ✗ **Requires coordination across jurisdictions within municipality.** While SWM affects the whole city, big urban areas are often sub-divided into different municipal districts which each have mandates for SWM, and any PPP will require coordination across these different districts.

Due to these trade-offs, bringing in the private sector is best suited for large-scale and complex projects—perhaps city-wide centralised systems—where the upfront investments cover the costs of coordination, with the private sector managing risk and facilitating innovation. To organise successful PPPs, municipalities must have strong regulations that set clear and realistic rules governing the scope and reach of service delivery, tariff levels and structure, and service quality requirements. There also needs to be appropriate risk-sharing between public and private parties and terms for renegotiation included in the initial contract.

Poorly implemented partnerships with ill-defined responsibilities can lead to valuable resources being wasted. As in the case study below of Saida, Lebanon, failed PPPs can result in suboptimal solutions being adopted. If incentives and outputs are not clearly defined when tendering waste management services, PPPs may fail to deliver needed services to the community. Cost reductions may come at the cost of efficient and reliable services. As such, cities using PPPs should utilise clear and quantifiable criteria—such as KPIs—to ensure that services can be monitored, and results delivered according to contractual conditions.²¹

²¹ Collier P., Glaeser, E., Venables, T., Manwaring, P., Wani, S. (2023). Delivering urban development: PPPs and other procurement options for urban infrastructure and services.

Case study 2: Failing private engagement in Saida, Lebanon²²

The Municipality of Saida signed a 20-year PPP agreement in 2002 for a facility that treated segregated solid waste. The private sector partner was tasked with financing, building, operating, and maintaining the waste management facility, retaining the right to sort and sell recyclable materials. Further, the facility was planned to collect and separate organic waste to produce biogas and create organic fertiliser. It was the municipality's role to collect waste and transfer the contracted amount to the facility.

However, poor waste collection practices led to problems in meeting the technological requirements of the treatment plant. The municipality continued collecting mixed waste from garbage cans outside of residences on an infrequent basis. The mixed waste reduced the quality of compost generated by the private sector partner, rendering the plan for organic waste collection impossible. Since households were not separating waste and organic waste was not collected frequently enough, the technology used by the plan was inoperable. Further, the private sector partner reported that revenues from the produced compost were too low, making the recovery of operational costs impossible.²³

Consequently, the processing facility shut down for three years and the contract required re-negotiation to simplify the technology. The waste could not be commoditised to its highest value, and the municipality ended up having to pay a fixed fee of \$95 per ton of waste treated. This was rather different from the plant making a profit from electricity production and fertiliser generation as originally intended.

Private actors can also have their own interests and motivations to get involved in SWM outside of the municipal system—usually where there is value to be generated from waste materials. In municipalities where the public sector does not provide comprehensive management for all kinds of waste, private actors may find opportunities for revenue generation by providing composting, reuse, or recycling services. This has been the case in Accra, Ghana, where companies are further processing waste to make biogas and animal feed.²⁴

22 Straub, S. and Moussa, S. (2019) *Lessons from Public Private Partnerships in Lebanon*. London: International Growth Centre.

23 Farah, J., Ghaddar, R., Nasr, E., Nasr, R., Wehbe, H., & Verdeil, É. (2020). *Solid waste management in Lebanon: Lessons for decentralisation*. Democracy Reporting International].

24 Oteng-Ababio, M., Forkuo Amankwaa, E., Fiifi Boadi, G. (2023). Managing Solid Waste for a Sustainable Accra. *International Growth Centre Policy Paper*.

Regulations create the conditions within which private actors may or may not engage in SWM. For example, there is a clear correlation between waste segregation and private engagement. Data from over 100 cities shows segregation is one of the largest drivers of ensuring a complete waste service, with the private sector playing a significant role in achieving this.²⁵ In Kampala, Uganda, higher income residential areas segregate more, involving more private operators who capture value from waste.²⁶

Regulations create the conditions within which private actors may or may not engage in SWM. There is a clear correlation between waste segregation and private engagement

In some cases, private involvement is still heavily reliant on municipal funding and administration, as seen in Case Study 2 below – the costs of such programmes need to be carefully weighed against the benefits to ensure they are sustainable in the long term.

Case study 3: Organic waste buyback and creating markets for waste in Cajicá, Colombia²⁷

In 2005, Cajicá, a small city located near Bogotá, implemented a pilot composting program that required the separation of organic waste at the source. The composting program distributed free green containers throughout the community for organic waste, with weekly household collection. Municipal officials also visited residences every two months to distribute *bokashi*, a mix of microorganisms to help accelerate the composting process in the green containers, reduce odours, and limit pest problems.

A private company then collected the organic waste, turning it into compost. Rather than paying households directly, the municipality “bought back” the waste by providing households with compost each month to use in their private gardens. The project launch was also paired with an awareness program to encourage citizens to sort and recycle waste, using simple guides and infographics to help households adhere to the program’s standard. SWM staff provided these educational programs, minimising additional costs.

25 Banerjee, S., & Sarkhel, P. (2020). Municipal solid waste management, household and local government participation: a cross country analysis. *Journal of Environmental Planning and Management*, 63(2), 210-235.

26 Kinobe, J. R., Niwagaba, C. B., Gebresenbet, G., Komakech, A. J., & Vinnerås, B. (2015). Mapping out the solid waste generation and collection models: The case of Kampala City. *Journal of the Air & Waste Management Association*, 65(2), 197-205.

27 Hettiarachchi, H., Meegoda, J. N., & Ryu, S. (2018). Organic waste buyback as a viable method to enhance sustainable municipal solid waste management in developing countries. *International Journal of Environmental Research and Public Health*, 15(11), 2483.

While the composting project has been successful, the organic waste program required high financial and administrative investment to cover the costs of education, needing approximately USD 350,000 per year in municipal funds. Further, the household-based collection approach increased labour costs in the SWM department. While the composting program provided clear benefits for households and the private sector partner, the program is dependent on the city's continued engagement.

Despite the high costs of the buyback program, Cajicá's composting model has resulted in several successes. Citizens have adapted to source separation of waste due to the awareness campaigns. This segregation at the source has allowed organic waste recovery to rise from 768 tonnes in 2009 to 2,364 tonnes in 2014. The program diverted organic waste from other waste disposal sites. This resulted in a 14% reduction of refuse disposed in landfills in 2009, within one year of the full program implementation.

Integrating informal collectors and waste pickers

In many developing economies, the informal sector—defined by unregistered and unregulated waste collectors—has created an important niche for themselves, servicing areas otherwise abandoned by formal service operators. They provide low-cost recovery and last-mile coverage where formal routes are uneconomical. In 2013, of the 19-24 million workers globally in the waste sector, approximately 80% were estimated to be informally employed.²⁸ These include both informal collectors who collect door to door and take waste to landfills, as well as 'waste pickers' or recyclers who extract valuables from waste and sell them to earn a living.²⁹

In 2013, of 19-24 million workers in the waste sector, approximately 80% were estimated to be informally employed

Informal workers can provide waste management services that formal service providers are not able to deliver, helping to improve the hygiene of municipalities and preventing waste from being dumped, burned, or disposed of in municipal landfills. In Accra, Ghana, more than half of waste collection is informal, with poor spatial planning and lack of accessibility inhibiting formal service delivery. Furthermore, only 10% of the city's reclaimable waste is recycled, and informal pickers provide the majority of these recycling services.³⁰ In other cities, for example those in Brazil, most collection is formally conducted by municipalities, but recycling remains informal.

28 International Labour Office. (2013). Sustainable development, decent work and green jobs. International Labour Office.

29 Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat international*, 30(4), 797-808.

30 Oteng-Ababio, M., Forkuo Amankwaa, E., Fiifi Boadi, G. (2023). Managing Solid Waste for a Sustainable Accra. IGC Policy Paper.

Informal waste collectors mostly earn through selling recyclable materials they collect to middlemen or recycling centres. In some more limited cases, they may also negotiate a collection fee with households where no formal service takes place. Incorporating informal workers into the SWM system brings several benefits, including:

- ✓ **Increasing the lifespan of landfills.** Informal pickers can prolong the lifespan of existing landfills by sorting waste and reducing the amount of waste going to them by diverting recyclables.
- ✓ Providing **SWM services to neighbourhoods** that may not be covered by formal sector collection and transportation services. In Accra, Ghana, formal services do not cover slums, emerging neighbourhoods, and lower-income areas. Consequently, the informal sector serves these areas and may provide flexible collection and pricing to accommodate household needs.³¹
- ✓ **Providing inputs to recycling markets.** For instance, in Tunisia, 8,000 'Barbechas' (waste pickers) recycle almost 60% of plastic annually.³² In Brazil, informal recyclers are responsible for the country's 80% recycling of cardboard and 92% recycling of aluminium.³³
- ✓ Providing a **critical livelihood** to many people in lower-income countries. In Accra, Ghana, informal waste collectors and pickers are often women, who have been traditionally responsible for sanitation, and the poorest individuals in the community.³⁴ The informal sector allows marginalised individuals to earn money and provide services to lower-income neighbourhoods. For some in Beijing, China, waste picking is seen as providing more freedom than manufacturing work, with a lower risk of unpaid wages.³⁵

However, informality also brings several challenges:

- ✗ Informal waste collectors and pickers face economic insecurity, social marginalisation and occupational health hazards. **More than 15 million informal waste pickers in the world are women, children, the elderly, unemployed, or migrants.**³⁶ In Accra, Ghana, waste pickers are perceived as unclean or improper, leading to conflict with city authorities and municipal attempts to disrupt the informal sector.³⁷

³¹ Ibid.

³² Scheinberg, A., & Savain, R. (2015). Valuing informal integration: Inclusive recycling in North Africa and the Middle East. GIZ.

³³ Dias, S. M. (2011). "Statistics on Waste Pickers in Brazil", (WIEGO Statistical Brief No 2, Issue.

³⁴ Oteng-Ababio, M., Forkuo Amankwaa, E., Fiifi Boadi, G. (2023). Managing Solid Waste for a Sustainable Accra. IGC Policy Paper.

³⁵ Ming, W. and Jieying, Z. (2017). Living with Waste: Economies, Communities and Spaces of Waste Collectors in China. *China Perspectives*.

³⁶ Hoornweg, D., & Bhada-Tata, P. (2012). What a waste: a global review of solid waste management.

³⁷ Oteng-Ababio, M., Forkuo Amankwaa, E., Fiifi Boadi, G. (2023). Managing Solid Waste for a Sustainable Accra. IGC Policy Paper.

- ✗ Informal collectors often handle waste without proper safety gear, which **impacts their health adversely**.
- ✗ Because municipal authorities do not coordinate these activities, relying on the informal sector for service delivery can result in **uncoordinated and inconsistent services**. Lack of harmonisation may lead to increased illegal disposal if neither formal nor informal provision is accessible.

Although often considered backward, unhygienic, and incompatible with modern waste management by municipal authorities and other residents³⁸, the informal sector exists due to poor socio-economic conditions and inadequate waste management by the municipality. It acts as a social safety net for the unemployed, particularly urban migrants and women.

While the goal might be to move to formalised systems, this comes at a high cost to municipal governments, and can disrupt livelihoods in the short term. In the interim, municipalities can aim to mainstream and improve existing informal collection and recycling. This can include training programs, providing safety equipment, as well as engaging with and recognising waste pickers' associations. The result is to both streamline recycling systems and protect informal workers' wellbeing and working conditions. Organising the informal sector in this way improves waste collection services and creates employment, without requiring significant additional municipal spending on waste collection.

Cities in Colombia, Brazil, and India³⁹ have managed waste successfully by integrating informal waste workers in the waste management system. Bogotá, Colombia achieved this through court rulings recognising the contributions of waste pickers granting them rights and remuneration. Belo Horizonte, Brazil integrated local cooperatives as formal partners to the city's waste management authority enabling them to participate in household recycling schemes. Finally, in Pune, India the local government engaged the waste workers' union and provided them the right to sell recyclable materials, compensated through user fees. These approaches can greatly improve the lives of informal waste collectors and pickers, with improved dignity, safety, and productivity.⁴⁰ The case study below details some of these contributions.

38 Wilson, D. C., Velis, C., & Cheeseman, C. (2006). Role of informal sector recycling in waste management in developing countries. *Habitat international*, 30(4), 797-808.

39 Dias, S. M. (2016). Waste pickers and cities. *Environment and Urbanization*, 28(2), 375-390.

40 Dias, S. M. (2011). "Statistics on Waste Pickers in Brazil", (WIEGO Statistical Brief No 2, Issue.

Case study 4: Informal waste pickers in Brazil⁴¹



Women waste pickers are climate change frontliners in the cooperative movement in Brazil⁴²

In Brazil, large proportions of the urban population are involved in the informal waste picking sector. Poor pay, operational hazards, and unhygienic conditions marred their living conditions. As of 2019, approximately 281,000 waste pickers worked in Brazil, with 30% of these individuals being women and most workers located in urban areas. Most waste pickers worked over forty hours per week and earned less than the national average in the country, with some workers receiving no pay. With little government or institutional support, waste pickers were marginalised despite providing a key service to Brazil's cities.

In the early 2000s, with the intervention of NGOs, waste pickers in Brazil organised themselves into co-operative businesses, launching a movement that aimed to bring public attention to their issues. Their work led the national government to facilitate aid to their cooperative business through the Brazilian Development Bank, and recognise their contributions officially as part of the Brazilian Classification of Occupations. These programs allowed the Brazilian Development Bank to launch financing lines for waste picker cooperatives, aiming to create jobs for informal workers in cities across Brazil. Further, the creation of marketing networks in large cities brought together associations and cooperatives allowed for the gathering of large volumes of recycling materials, delivered directly to industry partners.

⁴¹ Dias, S. M. (2018). Creating Decent Jobs Through Waste Pickers Cooperatives. *Urbanet*.

⁴² Photo Sonia Dias Archive

The private sector is also recognising the role of informal pickers. Cosmetics companies, multinational businesses, and industrial groups are building direct relationships with waste pickers. New, direct partnerships between waste picker co-operatives and private companies provide income and recognition for waste pickers.

While only a quarter of all Brazilian municipalities segregate their waste at the source, Brazil recycles 97% of cans and 67% of cardboard overall. These impressive recycling rates are due to the work of waste pickers, who provide a key SWM service in the absence of municipal coverage. Protecting these key workers ensures that waste pickers can continue their role with fair pay, health protection, and reasonable conditions.

While waste sector jobs can be numerous, and it provides a social safety net for many low-income and low-skilled workers, there is jeopardy in treating SWM as an employment programme. Municipal funds should be allocated based on public service needs and overall public benefit, rather than with the end-goal of job creation. Enabling the private sector to extract value and grow the market for waste is often more effective for sustainable job creation.

There is jeopardy in treating SWM as an employment programme. Municipal funds should be allocated based on public service needs and overall public benefit, rather than with the end-goal of job creation.



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3. What can municipalities do to improve compliance and enforcement?

Once a functional formal system for waste management is put in place, public acceptance and compliance with norms and regulations become a key component to its success.⁴³ Individuals must be encouraged to stop harmful practices such as illegal dumping and littering. They can also be encouraged to properly segregate waste, to enable more profitable and sustainable methods of disposal. Engagement with communities and populations is therefore a crucial component in functional waste management systems

Compliance rises when the cost of bad behaviour exceeds the cost of compliance. It can be achieved through using fines and regulations to penalise non-compliance as well as offering incentives and building awareness to encourage voluntary compliance.

While waste management brings significant city-wide benefits, the individual effort required can often outweigh the benefits for households.

Fines and regulations to penalise non-compliance

Citizens will often start by seeking to dispose of waste in the simplest and most accessible way possible. While waste management brings significant city-wide benefits, the individual effort required can often outweigh the benefits for households, deterring people from contributing to the public good. The mismatch between municipal needs and citizen preferences creates a significant challenge for successful waste management.

One way to deal with this is by penalising non-compliance. In theory, if the penalty is sufficient, and threat of being caught is viable, then residents should be deterred from acting against the regulation. However, there are many issues that confound this in practice.

The first step towards creating viable and effective sanctions for poor SWM practices is having clear rules. However, policies related to waste disposal and littering often fall under the responsibility of numerous ministries, as is the case in Ghana with the Ministry of Environment, Science, Technology and Innovation; the Ministry of Sanitation and Water Resources; and the Ministry of Local Government and Rural Development all operating independently on aspects of SWM.⁴⁴ A lack of coordination between national and local authorities can lead to unclear and sometimes conflicting policies, raising uncertainty on which authority is

43 Achillas, C., Vlachokostas, C., Moussiopoulos, N., Baniyas, G., Kafetzopoulos, G., & Karagiannidis, A. (2011). Social acceptance for the development of a waste-to-energy plant in an urban area. *Resources, Conservation and Recycling*, 55(9), 857-863.

44 Oteng-Ababio, M., Forkuo Amankwaa, E., Fiifi Boadi, G. (2023). Managing Solid Waste for a Sustainable Accra. *IGC Policy Paper*.



responsible for enforcement and the minimum standards for SWM, and lowering perceived enforcement.⁴⁵

The cost and severity of fines and sanctions also impacts the degree to which citizens recognise the threat of punishment and the likelihood of reprisal. They must be high enough to disincentivise illegal disposal, but not so high that they encourage hiding behaviour and bribery, in turn eroding legitimacy. One approach is using 'day-fines', calculated considering both the income of the offender and the severity of the offence, thus equally deterring the wealthy and poor.⁴⁶ Others argue that the fine level should at least compensate the cost of catching the citizen and compensate society for the harm they directly do.⁴⁷ Low-income areas, where the bulk of waste management violations occur, are also the most challenging places to implement fines due to low ability and willingness to pay.

Fines must be high enough to disincentivise illegal disposal, but not so high that they encourage hiding behaviour and bribery.

As illustrated in **Box 2**, Rwanda's successful ban of single-use plastic bags was successful due to a combination of effective policy enforcement, and citizen awareness.

45 United States Environmental Protection Agency. (2020). Best Practices for Solid Waste Management: A Guide for Decision-Makers in Developing Countries. EPA.

46 Kantorowicz-Reznichenko, E. (2015). Day-Fines: Should the Rich Pay More?. *Review of Law & Economics*, 11(3), 481-501.

47 Becker, G. S. (1968). Crime and Punishment: An Economic Approach. *Journal of political Economy*, 76(2), 169-217.

Case study 5: Banning single-use plastic bags in Rwanda⁴⁸

In 2008, Rwanda implemented **a nationwide ban on single-use plastic bags**. While many jurisdictions have attempted to put in place similar restrictions on plastic bags, long-term enforcement of single-use plastic bans have been challenging. In contrast, Rwanda has successfully implemented this policy, with Kigali being nicknamed “the cleanest city in Africa.” The policy mix combined **deterrence** (high, certain sanctions), **substitutes** (affordable alternatives), and **salience** (persistent communication), raising the **expected cost** of non-compliance while lowering the **transaction cost** of compliance.

Rwanda’s approach involved a combination of **public awareness campaigns**, thorough **enforcement provisions**, and **private sector participation**. First, the national government enacted education campaigns about the detrimental environmental impact of plastic bags and the benefits of the bans to foster a sense of ownership among citizens. Rwanda’s Umuganda programs, which brought people between the ages of 16 to 65 together for community service, were used as weekly opportunities to inform citizens about the harmful effects of single-use plastics.

Second, Rwanda implemented thorough enforcement provisions to ensure compliance with the ban by **banning the importation, production, usage or sale of plastic bags**. Violators can face a fine of approximately 50,000 francs (USD 61) for infractions or jail time for repeated offenses. Customs inspections at borders and airports help prevent the smuggling of plastic bags into the country. **Strict enforcement** and **heavy fines** provide a clear disincentive for rule-breaking and uphold Rwanda’s zero-tolerance policy for plastic bags.

The private sector has also provided **alternatives and solutions** in response to the ban. Local entrepreneurs have begun to make recycled paper bags and packaging to meet the new need for alternative packaging. Rwandan manufacturers, facing increased fees and a lack of affordable **alternative packaging solutions**, have worked with waste management companies to recycle materials after their initial usage. Some manufacturers were also able to anticipate the transition and shifted their production to **paper-based packaging**. However, the plastic bag ban has increased packaging costs for traders, leading to some fees being passed onto customers.

In Rwanda, public education, strict enforcement, and private sector responsiveness have led to a long-term, successful implementation of a single-use plastic bag ban. Although this policy has not been without costs for local businesses, entrepreneurs, and manufacturers, the government has maintained a zero-tolerance approach to plastic bags for over fifteen years. Rwanda’s practices have since been shared with other developing countries to provide new ideas for how countries can reduce plastic pollution and successfully pursue similar policies in their own national contexts.

48 Chen, S., & Redkar-Palepu, V. (2023). Umuganda: Rwanda’s audacity of hope to end plastic pollution. Mukurarinda, J. (2023, 2025-07-08). Rwanda: lessons learnt from a pioneer in the fight against plastic pollution. Plastic Oceans International. (2021, 2025-07-08). Rwanda Plastic Bag Ban. Rosen, J. W. (2016, 2025-07-08). Rwanda’s War on Plastic. Ogutu, M. O., Akor, J., Mulindwa, M. S., Heshima, O., & Nsengimana, C. (2023). Implementing circular economy and sustainability policies in Rwanda: Experiences of Rwandan manufacturers with the plastic ban policy. *Frontiers in Sustainability*.

Sanctions only deter when they are **credible**. Hence, monitoring and enforcement are also necessary for sanctions to be credible and effective. For example, evidence in Zhengzhou, China, found that enforcement had a direct impact on waste segregation behaviour.⁴⁹ However, getting this right is a challenge for all municipalities, and requires considerable administrative effort and capacity.

In addition to a clear legal framework, municipalities face a make-or-buy choice: inspectors vs technology, comparing the cost of detection with accuracy. The former requires significant human resources - hiring and training of enforcement officers that can identify environmental violations and distribute fines to those responsible. The latter is cheaper, and in some cases can be very effective in detecting violations. For example, cameras and artificial intelligence to monitor illegal dumping.⁵⁰ These methods have been found to identify illegal dumpers—humans and vehicles—with an accuracy of 93%.

Enlisting the help of the community is another lower-cost way to monitor and enforce compliance. Here, citizens are incentivised to identify and report violations, as municipal authorities cannot continually police all areas. For example, Moshi, Tanzania, has implemented an environment and cleanliness by-law, in which any individual can report another community member for littering and, with evidence, administer the fine. After submitting it a local ward council, the person administering the fine may keep half of it—adding a financial incentive. To minimise system abuse, there is an appeals process in place.⁵¹

This appeals process is important: while community reporting reduces monitoring costs and uses local information, it can also be problematic, with individuals using it to punish neighbours or extract rents. There is also no way to ensure consistency in enforcement across neighbourhoods.

Figure 4 below illustrates a campaign in Brighton, U.K. to raise awareness about the financial and legal implications of fly-tipping. This example from also includes community enforcement information, thus encouraging individuals to get involved in reporting illegal dumping.

49 Hao, M., Xu, S. (2023). The Impact of Penalty on Residents' Waste Separation Behavior: A Moderated Mediation Model. *Polish Journal of Environmental Studies*, 32(2), 1145-1158.

50 Fang, B., Yu, J., Chen, Z., Osman, A.I., Farghali, M., Ihara, I., Hamza, E.H., Rooney, D.W. and Yap, P.S., 2023. Artificial intelligence for waste management in smart cities: a review. *Environmental Chemistry Letters*, 21(4), pp.1959-1989.

51 Majoe, N., & Currie, P. (n.d.). Environmental cleanliness in Moshi, Tanzania.

Figure 4: Visible fines and sanctions with reporting mechanisms in Brighton, U.K.



Raising awareness and building trust to encourage voluntary compliance

Enforcement moves the **stick**. Yet sustained compliance also needs the **carrot**: information that lowers compliance costs, and trust that raises willingness to cooperate. Encouraging voluntary compliance can be done through awareness and sensitisation, building the social contract, making use of behavioural nudges, or offering incentives. Compared to penalising non-compliance, which only works where authorities have the capacity and power to enforce certain actions, voluntary compliance depends largely on understanding, social norms, and trust in authorities.⁵² Empirical evidence indicates that including voluntary aspects can also be more effective than penalties in reaching overall compliance.⁵³

52 Muehlbacher, S., Kirchler, E., & Schwarzenberger, H. (2011). Voluntary versus enforced tax compliance: Empirical evidence for the “slippery slope” framework. *European Journal of Law and Economics*, 32, 89-97.

53 Aryampa, S., Maheshwari, B., Sabiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. *Sustainability*, 11(19), 5523.

Awareness and sensitisation

Disposal sites are often located on the urban fringes, out of sight of residents, and therefore city dwellers are not fully conscious of the consequences of their waste disposal.⁵⁴ Public education and awareness-building programs can help inform citizens of the impact of mismanaging waste, as well as the available services and their obligations.

For example, the figure below highlights a campaign in London, U.K., to educate citizens on potential solutions to get rid of bulky waste. It indicates the ease and cost of different levels of compliance to build more awareness on the consequences of actions.

Figure 5: Increasing awareness and encouraging compliance with options for waste disposal in London, U.K.



In Quelimane, Mozambique, providing information on the link between urban flooding and solid waste blocking drains increased mitigation efforts to clean up drains before the rainy season, reducing the presence of solid waste disposal in sewage canals by 8-15%.⁵⁵

⁵⁴ Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. Sustainability, 11(19), 5523.

⁵⁵ Leefters, S. (2023). *It Will Rain: The Effects of Information on Flood Preparedness in Urban Mozambique*.

Experience and awareness often differs between different population groups; for example, in South Africa and Colombia, older household members demonstrated more awareness of environmental concerns and therefore higher levels of waste segregation.⁵⁶ Here, targeting by demographic can raise **cost-effectiveness** of campaigns. Similarly, integrating environmental principles into curriculums and improving school-based educational programs can provide a key support in establishing good SWM practices.

Public dissemination of environmental messaging through cinemas, street plays, workshops, or media campaigns can also be effective in reaching individuals outside of the formal education system.⁵⁷ To be successful, evidence shows that campaigns need to be carried out in both formal and informal settings, and having local leaders involved can also contribute to strong buy-in of the community.

These campaigns can also be self-reinforcing. As community awareness spreads, it builds momentum within and across neighbourhoods. The behaviour of one citizen can influence fellow citizens' behaviour, and as a critical mass is reached, a new social norm takes hold. For example, in the Lake Victoria Crescent, Uganda, having friends or family who reuse waste increased likelihood of households in urban areas reusing waste themselves by 80%.⁵⁸ Social pressure and an individual's social desirability bias can work together to ensure compliance with the prevailing SWM standards. However, this is conditional on residents having the resources to comply.

Some indications show that the total cost of municipal SWM can be reduced by 40% if education and awareness programs are successful.⁵⁹ Evidence also shows that, when it comes to encouraging SWM compliance, awareness and knowledge can be even more important than the provision of adequate equipment or enhancing collection efficiency.⁶⁰

The case study of three cities in India below illustrates how successful sensitisation campaigns, education and training can actively improve compliance with SWM segregation.

56 Debrah, J. K., Vidal, D. G., & Dinis, M. A. P. (2021). Raising awareness on solid waste management through formal education for sustainability: A developing countries evidence review. *Recycling*, 6(1), 6.

57 Festus, M. O., & Ogoegbunam, O. B. (2012). Imperatives of environmental education and awareness creation to solid waste management in Nigeria. *Academic Research International*, 3(2), 253.

58 Ekere, W., Mugisha, J., & Drake, L. (2009). Factors influencing waste separation and utilization among households in the Lake Victoria crescent, Uganda. *Waste Management*, 29(12), 3047-3051.

59 Mofid-Nakhaee, E., Barzinpour, F., & Pishvaei, M. S. (2020). A sustainable municipal solid waste system design considering public awareness and education: A case study. *Waste Management & Research*, 38(6), 626-638.

60 Guerrero, L. A., Maas, G., & Hogland, W. (2013). Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1), 220-232.

Case study 6: Waste segregation awareness and communication campaigns in India⁶¹

In India, various awareness and communication campaigns in different cities have been successful in encouraging behavioural change.

Delhi, India generates 9,250 metric tonnes of waste per day. The legal framework of the Municipal Solid Waste Rules from 2016 mandates waste segregation at source and community participation in SWM. Despite this and many other rules, awareness among the citizens regarding waste segregation and need for proper waste disposal is poor. To counter this, an intervention was conducted in Delhi to sensitise households about waste segregation and the importance of proper waste disposal. All households in selected neighbourhoods received dustbins, garbage bags, and information brochures detailing the solid waste management rules in Hindi and English. The brochures defined biodegradable waste, the environmental benefits of waste segregation, and information about the average weight of household waste in the locality. Some households also received Rs. 50 as an incentive to segregate waste. **Among households who received the sensitisation, segregation levels increased from 4% to 54%** a week after the interventions.

Similar results were found in Patna, India, where six months after informing and training residents in waste management, there was a 2.5x increase in segregation rates.⁶²



⁶¹ Wadehra, S., & Mishra, A. (2017). Managing waste at the household level: Field Evidence from Delhi. IGC.

⁶² Dhingra, S., Kondiroli, F., and Machin, S. (2022). Towards Zero Waste: Segregation at Source Can Reduce Our Waste Footprint. LSE, CEP.

Wider communication campaigns can also support SWM initiatives. Indore, the capital of the state of Madhya Pradesh in India, was ranked the cleanest city in the Government of India's Clean India Mission cleanliness survey. This survey is based on service level progress (collection, segregation at source) and certification, such as Open Defecation Free and Garbage Free Star Ratings. Indore credits its success to citizens' participation and awareness.⁶³

The local body carried out intense Information and Communication campaigns through audio-visual, print, and electronic media to induce behavioural change. Novel measures such as local street plays and painting competitions were organised with NGO groups to sensitise people to the manner of waste segregation. These ongoing campaigns led to a rise in awareness towards waste management, deterring citizens from dumping their garbage in the open. They also increased standards of waste segregation at the source for all households and commercial units.

Building the social contract for long term change

While information shifts beliefs in the short run, trust sustains behaviour in the long run. Thus, in addition to raising awareness, there is a need to build a long-term social contract between the people and the municipality to maintain compliance. That is – a high level of trust both that the municipality will deliver on its mandate, and that citizens will comply with regulations set out.

This requires the government to ensure waste management infrastructure is in place, with service reliability reducing the cost of compliance. Furthermore, although specific SWM actions by the municipality play an important role, the social contract will also depend on the degree to which individuals have high levels of social trust and social participation outside of SWM activities as well.⁶⁴ In other words, existing social capital, interpersonal trust, and attitudes towards government authorities directly impact the effectiveness of SWM initiatives.⁶⁵

For example, in Lahore and Faisalabad, Pakistan, trust in local government was built by ensuring a faster pace of local public good delivery as well as enhanced messaging to citizens.⁶⁶ The messaging included information on the direct services provided and how the community participation drove tangible local improvements.

63 Indore, City of (2018). Region 3R Forum, Asia-Pacific. In.

64 Zhou, Y., Song, H., Huang, X., Chen, H., & Wei, W. (2022). How Does Social Capital Affect Residents' Waste-Separation Behavior? Evidence from China. *International Journal of Environmental Research and Public Health*, 19(6), 3469.

65 Prelikova, E & Vitaliy, Zotov & Yushin, V. (2020). Management of Local Community Social Capital when Solving the Problems of Urban Environment Pollution with Solid Municipal Waste. *IOP Conference Series: Earth and Environmental Science*. 459. 032065. 10.1088/1755-1315/459/3/032065.

66 Khan, A., Kwaja, A., Olken, B. and Shaukat, M. (2022). Rebuilding the social compact: Urban service delivery and property taxes in Pakistan. Final Report. IGC.

Engagement with local leaders and citizen participation are also critical for building trust. Evidence indicates that any actions that require compliance are more successful if set by the community, or agreed upon in consultation with them.⁶⁷ For example, the pricing of solid waste management services, and the citing of skip locations all need buy-in from the service beneficiaries. A cross-country study of 36 cities shows that engagement with the community also results in better allocation of funding for SWM equipment. This investment encourages stakeholders, and they are more willing to participate in SWM processes.

Evidence from 32 cities shows that building the social contract is significant in positively changing SWM practices at household level

The figure below shows how in the UK, the waste collection truck explicitly indicates where each element of segregated waste goes—highlighting the city council is doing their part and incentivising citizens to maintain compliance.

Figure 6: Kerb-side collection with segregation and ensuring value from waste in Bath, U.K.



Municipalities often hesitate to invest in these interventions due to their intangibility and the long time it takes to build trust and reap the benefits. However, evidence from 32 cities, including Lusaka, Zambia; Lilongwe, Malawi; and Lahore, Pakistan have shown that building the social contract is significant in positively changing SWM practices at the household level.⁶⁸ With trust in place, low-cost behavioural tools can then lock in norms and scale compliance.

67 Tyrn, J.-R., & Feld, L. P. (2006). Achieving Compliance when Legal Sanctions are Non-deterrent*. *The Scandinavian Journal of Economics*, 108(1), 135-156.

68 Guerrero, L. A., G. Maas and W. Hogland (2013). "Solid waste management challenges for cities in developing countries." *Waste management* 33(1): 220-232.

Using competitions and behavioural nudges to encourage compliance

In addition to educating citizens and building the social contract, municipalities can use competitions and behavioural nudges to encourage citizens to adopt new SWM norms.

Some behavioural nudges for SWM can include:

- **Larger bins for recyclables.** Providing larger containers for recyclable items compared to regular trash bins encourages people to sort their waste better.⁶⁹
- **Signage and notifications.** Providing signs or stickers reminding individuals of the environmental impact of dumping waste in high-traffic areas can help reduce illegal disposal.⁷⁰
- **Surveys and ranking.** Cities are evaluated for their cleanliness, sanitation, and SWM infrastructure in publicised rankings, with high-performing cities receiving special titles and recognition.⁷¹
- **Waste audits.** Volunteers collect plastic waste along coastlines, noting the brand names, packaging types, and product producers. In the Philippines, this data was shared with households about the results of the study, making households aware about the environmental impact of waste generation and increased both community and corporate awareness of litter.⁷²
- **Clear bags.** Municipalities can require households to dispose of their waste in clear plastic bags, which allows waste collectors to evaluate whether the waste is segregated. It also permits the community to see whether households recycle or properly dispose of waste. In Halifax, Canada, this “moral nudge” resulted in an increase in recycling by 15% and a decrease of total municipal solid waste by 27% over two years.⁷³

69 Samaranayake, D. I. J. & Thennakoon, Ruwanthika. (2021). Could Behavioural Nudges Improve the Accuracy of Waste Sorting? An Experimental Survey. *Environment and Pollution*. 10. 1-15. 10.5539/ep.v10n1p1.

70 Samaranayake, D. I. J. & Thennakoon, Ruwanthika. (2021). Could Behavioural Nudges Improve the Accuracy of Waste Sorting? An Experimental Survey. *Environment and Pollution*. 10. 1-15. 10.5539/ep.v10n1p1.

71 World Bank. (n.d.) Behavior Change in Solid Waste Management. A Compendium of Cases.

72 World Bank. (n.d.) Behavior Change in Solid Waste Management. A Compendium of Cases.

73 Akbulut-Yuksel, M., & Boulatoff, C. (2021). The effects of a green nudge on municipal solid waste: Evidence from a clear bag policy. *Journal of Environmental Economics and Management*, 106, 102404.

Competitions are another way to instil new behaviours and set new social norms. For example, Moshi in Tanzania has put in place a competition for 'cleanest ward', to nudge citizens and promote good performance in collection and cleanliness. This together with information campaigns and the penalties discussed earlier have resulted in the city winning the title of cleanest city in Tanzania for several years.⁷⁴ The case study below provides more detail on a similar initiative in Freetown, Sierra Leone, with the Council's attempt to change compliance through competition.

Case study 7: Community compliance and self-regulation in Freetown, Sierra Leone

Freetown's Cleanest Zone competition pits the city's neighbourhoods against each other for a number of prizes, including solar-powered street lights, water points, paved roads, and school scholarships.⁷⁵ Winners are assessed based on specific criteria, such as cleanliness (for example, drains and public areas free of waste), beautification (for example, green space or street art) as well as sustainable and innovative solutions (for example, solid waste separated at source).⁷⁶ Furthermore, if anyone in the community is caught illegally dumping either liquid or solid waste, their entire zone is immediately disqualified.⁷⁷

These community prize incentives, when combined with self-enforcement and regulation, are important to change waste practices. In a city where 80% of waste could be recycled or used as compost, such schemes have wider benefits, particularly by saving taxpayers money clearing waste from overflowing drains and providing economic opportunity for unemployed youth.⁷⁸

74 Wilson, D. C. (2015). *Global waste management outlook*, International Solid Waste Association, Issue.

75 FCC. (n.d.-c). *Targets & Initiatives for Sanitation*.

76 FCC. (n.d.-a). *Cleanest Zone Assessment Criteria*.

77 FCC. (n.d.-b). *Cleanest Zone Rules*.

78 UNDP. (2018). *Solving Freetown's waste problem*.

4. What are the funding options for sustainable solid waste management?

Depending on the technology chosen, solid waste management can be a capital-intensive task requiring robust initial financing mechanisms, as well as funding for ongoing spend on operations.

Upfront capital costs typically include waste collection infrastructure such as vehicles and transfer stations, waste treatment and processing facilities, final disposal infrastructure such as landfills or dumpsites, as well as associated institutional and system investments. The costs vary depending on the level of technology used, and how centralised the system is.

This is typically funded through a mix of national government transfers and/or development partner financing, including climate finance. While private resources can also be leveraged, the public-good nature of SWM means that it will always require some level of public investment to deliver a clean city for all.

The ongoing operational costs include labour, fuel and vehicle maintenance, operations of the various collection, transfer, treatment and disposal stations, street cleaning, administrative overheads, and environmental monitoring. This, together with any capital loan repayments, are typically covered by local government revenues.

The percentage of municipal budget devoted to SWM varies based on the municipalities' overall mandate, as well as the design and efficiency of their SWM system. At the lower end of the spectrum, Kigali, Rwanda and Dakar, Senegal allocate only 2-3% of total operating budget to SWM.⁷⁹ At the higher end, other cities may allocate 50% of their budget to such activities.⁸⁰

In Kigali, the budget allocated to SWM covers only fuel and personnel for collection, but is insufficient to cover other basic activities, such as operating sanitary landfills. This might keep the streets clean, but pushes waste problems elsewhere in the city. Furthermore, revenues collected from SWM fees only recover 12% of the total costs. While tariffs are artificially low, they might still be too high for low-and-mid income households, with a third of those reporting non-payment.⁸¹

Despite where financing is drawn from, many cities struggle to find cost recovery opportunities to fund waste management. This section explores funding options for SWM that both help in recouping costs and create fiscal incentives that support compliance as well. These can be both household charges, and fees levied at waste sites or on business.

79 Harman, O., Delbridge, V., Haas, A., Venables, A. J., & Dia Sarr, K. (2021). Enhancing the financial position of cities: evidence from Dakar. UNHabitat Case Study.

80 World Bank. (2019). *Solid Waste Management* (World Bank Briefs, Issue.)

81 Rajashekar, A., & Bowers, A. (2019). Assessing waste management services in Kigali. *International Growth Centre, Policy Brief*.

Household charges

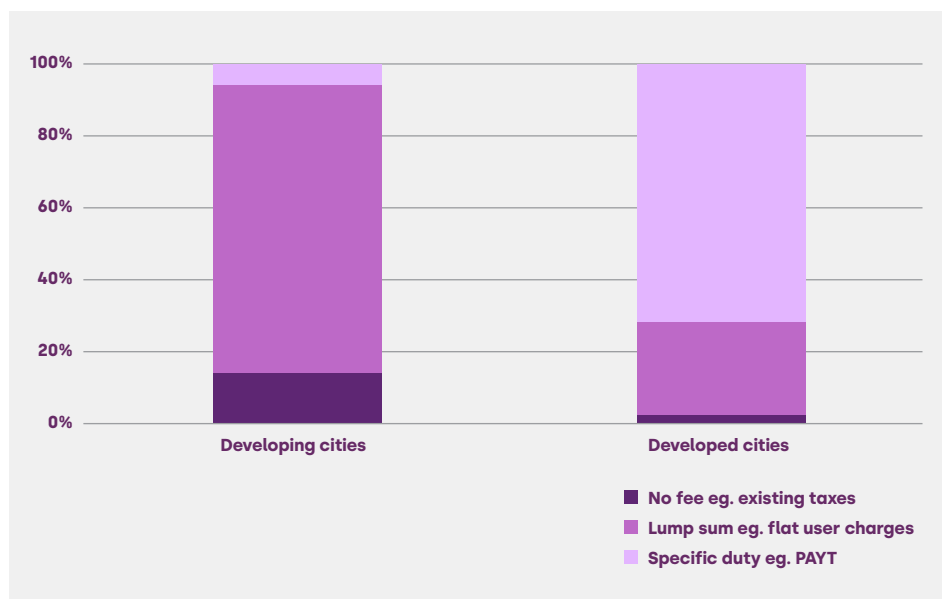
Municipalities can finance solid waste management through:

- Existing taxes
- Flat user charges
- Unit pricing/specific duty: Pay-as-you-throw⁸²

The chart below highlights the relative prevalence of these fee-types in developing and developed cities. Cities in developed countries have much higher use of specific duties, creating a financial incentive to monitor and reduce waste production. However, no fee or lump sum pricing is simpler to implement and less likely to incentivise informal dumping, and hence is more prevalent in developing cities. Where fixed costs dominate, a two-part tariff comprised of a fixed service fee and variable charge can balance revenue stability and incentives.

The following section discusses the trade-offs associated with each option and how their application can also help in driving both compliance with formal SWM systems and overall waste prevention.

Figure 7: Fee type for waste management in developing and developed cities⁸³



Note: Data from 103 cities covering 57 countries

⁸² Dohogne, J.-J. (2014). Waste Management Costs & Financing and Options for Cost Recovery (Horizon 2020 Capacity Building/ Mediterranean Environment Programme Issue.

⁸³ Banerjee, S., & Sarkhel, P. (2020). Municipal solid waste management, household and local government participation: a cross country analysis. *Journal of Environmental Planning and Management*, 63(2), 210-235.

Existing taxes

Many municipalities do not charge separate fees for SWM. They fund the function through existing taxes, such as property tax.⁸⁴

This system is easier to manage in low-capacity environments:

- ✓ **Lower resistance to payment**, since the payment of existing taxes is an established system.
- ✓ **Straightforward implementation**, as it saves the municipality the hassle of accounting for a separate service, with the existing tax collection and payment mechanism used.
- ✓ **Does not incentivise illegal dumping** as there is no direct cost associated with correct disposal.

However, funding SWM through existing taxes has some drawbacks and problems:

- ✗ **Costs of service are hidden to citizens**, reducing transparency and the social contract.
- ✗ **Limited incentive to reduce waste** as the costs of disposal are not linked to the quantum of waste.
- ✗ **Inequity**, as there is no mechanism to charge more to high waste producers.

Funding SWM through existing taxes is administratively easier and, by virtue of not levying a direct cost on waste disposal itself, is most likely to encourage shifts away from illegal dumping. However, it does not directly incentivise waste reduction or segregation. In addition, the lack of connection between service cost and fees charged inhibits cost recovery. For example, Mzuzu, Malawi used property tax reforms to finance waste management vehicles and facilities as this service has no specific user fee.⁸⁵

Flat user charges

Some municipalities account for SWM as a specific utility head and charge separate flat fees for it. With flat user charges, both the municipality and the community are conscious of specific SWM costs. For example, in Mandalay, Myanmar homeowners are subject to three fees: a building tax, a street lighting fee and garbage collection. This separation of fees provides citizens more awareness of waste management and the municipalities' role in collecting it. Furthermore, with flat user charges (as in the case of existing charges above) the household will not get charged more for disposing of their waste, thereby encouraging compliance with the formal system. However, the

⁸⁴ Wilson, D. C. (2015). Global waste management outlook. *International Solid Waste Association*, Issue.

⁸⁵ Harman, O., Delbridge, V., Jangia, D., Haas, A., & Venables, A. J. (2021). Enhancing the financial positions of cities: evidence from Mzuzu. UNHabitat Case Study

same equity issue also arises: the additional cost of generating more waste is zero, and therefore these pricing mechanisms create systems where citizens have little or no financial pressure to reduce the waste they produce. In Dakar, Senegal, 9% of their budgeted revenues are from Household Waste Removal Tax, amounting to approximately USD 6.3 million, or USD 2 per person per year.⁸⁶

With a specific charge for waste management services, citizens' awareness of this service and expectations on the efficiency of the service will increase. The municipality must ensure they have the capacity to meet these expectations, and that the tax level is at an acceptable rate for households, or citizens are unlikely to pay.

The benefits are:

- ✓ **Straightforward implementation** as, although a separate line item needs to be billed, flat user charges do not require weighing waste or calculating fees. This makes the cost for users predictable and eases implementation for municipal officials.
- ✓ **Does not incentivise illegal dumping** as there is no direct cost associated with correct disposal.
- ✓ **Citizens are aware of waste collection costs** as user charges are associated directly with the service, engaging citizens and creating accountability.

But this approach also has key drawbacks:

- ✗ **Levying new user fees can create resistance** as residents have to acclimatise to paying for something they have not had to in the past.
- ✗ **Limited incentive to reduce waste**, as the costs of disposal are not linked to the quantum of waste.
- ✗ **Inequity**, as there is no mechanism to charge more to high waste producers.

Financing and funding SWM through flat user charges more explicitly connects citizens with the cost of their waste production, and encourages compliance with formal waste management practices. However, it requires sensitisation to a new fee and does not directly incentivise waste reduction, nor even segregation.

⁸⁶ Harman, O., Delbridge, V., Dia Sarr, K., Haas, A., & Venables, A. J. (2021). Enhancing the financial positions of cities: evidence from Dakar. UNHabitat Case Study



Rudolf Ernst via iStock

Furthermore, due to its flat nature, it would be distortionary to set the fee level high enough for full cost recovery. For example, in Senegal, the annual budget for waste collection is estimated at CFA 45 billion, but the dedicated solid waste management tax only brings in CFA 5 billion.⁸⁷ The flat nature of the fee and necessity to cover costs results in the fee being too high for low-income households while also relatively low for high-income households. Consequently, funding is sought from other sources such as inter-governmental transfers.

The case study below highlights how a city can adapt the flat user charge to account for higher or lower expected levels of waste generation, thereby improving equity and cost recovery.

⁸⁷ World Bank. (2017). *Senegal Municipal Solid Waste Management Project*. Project Information Document.

Case study 8: Matching waste payments with electricity charges in Maputo, Mozambique

A hybrid mechanism that includes the ease of a flat user charge but also accounts for higher charges for higher waste households is evidenced in Maputo, Mozambique. Following extensive public campaigns, a specific waste tax was introduced in 2003 and was attached to citizens' electricity bills.⁸⁸ Since electricity billing had an established collection system and covered 90% of households in Maputo, it made additional collection easy. In addition, since electricity is seen as a necessity, bundling waste management fees into electricity charges increased citizens' likelihood to pay.

Although it was estimated to take USD 2 per month per household to make the waste management system economically viable (less than 0.6% of average available income), the price was initially set at USD 0.8 per household with the plan to increase it incrementally to the USD 2.⁸⁹ This first rise was in 2007, delivered in a way that made higher-income households pay up to two times the tax of average-income households.

The fee was also linked to energy consumption of the household. Specifically, fees for waste management ranged from MZN 10 for consumption below 100kWh and MZN 80 for over 500kWh. Between 2004 to 2010, the municipality increased cost recovery from below 40% of the system to 62%. During this time the city also increased the percentage of households with access to regular service and collection quantity.⁹⁰

Pay-as-you-throw (PAYT)

To link private costs to waste generated, cities can shift to PAYT, ideally as a two-part tariff so fixed costs remain covered. PAYT itself is a unit-pricing model under which municipalities proportionally charge the people for the waste management services based on the waste they generate.⁹¹ The municipality decides whether it will collect all the waste: organic, inorganic and residual or just the residual. Cities also decide whether there would be differential tariffs for the different types of waste.⁹² There are a variety of approaches to PAYT, with municipalities having one or a mix of the following systems.⁹³

1. Fixed annual fees per household (accounting for certain household characteristics such as size)
2. Fees for purchasing mandatory waste bags (for example, for residual waste)

88 Ferrão, D. A. G. (2006). An examination of solid waste collection and disposal in Maputo City, Mozambique. University of Cape Town.

89 Stretz J (2012) Economic instruments in solid waste management. Eschborn, Germany: GIZ.

90 Stretz J (2012) Economic instruments in solid waste management. Eschborn, Germany: GIZ.

91 Folz, D. H., & Giles, J. N. (2002). Municipal Experience with "Pay-as-You-Throw" Policies: Findings from a National Survey. *State and Local Government Review*, 34(2), 105-115.

92 OVAM. (2014). *Good Practice Flanders: PAYT*.

93 Commission, E. (2012). *Use of Economic Instruments and Waste Management Performances*.

3. Fees per emptying of a bin
4. Fees per weight of waste

The benefits of PAYT are that:

- ✓ **Citizens are aware of direct costs of the waste** they produce, engaging citizens and creating accountability.
- ✓ **Incentivises reductions in waste**, either by segregating and recycling some materials or more conscious consumption, provided that they do not turn to informal disposal alternatives instead. Studies have shown that PAYT increases recycling rates by about 35%.⁹⁴ A **two-part PAYT** with fixed service fee and variable unit price stabilises revenue while keeping the incentive.
- ✓ **It is equitable**, as users pay proportionally for the waste they generate.

However, PAYT also has constraining factors:

- ✗ **Complex to implement**, demanding high initial administrative and capital expenditure from the municipality. These costs are required to provide customised storage containers, or for putting in place processes to monitor waste such as weighing and itemised billing to charge for it. If the system involves segregation, they also need to provide appropriate infrastructure to dispose of segregated waste correctly.⁹⁵ Finally, with citizens paying as they throw, timely collection is key, as they may only have one specific-sized bin or bag.
- ✗ **Levying a new fee based on quantum of waste can create resistance** as residents have to acclimatise to paying for something they have not had to in the past.
- ✗ **Can encourage illegal dumping**, where enforcement and compliance is low. This is a large concern in lower-income settings where municipalities have less capacity.

Funding SWM through specific duties such as PAYT ensures citizens pay for their fair share, and that they feel the direct cost of their waste production. In settings where there are high rates of compliance, this can be effective in incentivising waste reduction. If properly structured, it can also enhance cost recovery, with the largest producers paying the largest share. This takes place, for example in Ekurhuleni, South Africa where integrated tariffs based on waste type, disposal frequency and user categories has seen the municipality align costs with service demands.⁹⁶ However, in settings where incomes and enforcement are low, this can instead incentivise dumping and open burning.

⁹⁴ Miranda, M. L., & Aldy, J. E. (1998). Unit pricing of residential municipal solid waste: lessons from nine case study communities. *Journal of Environmental Management*, 52(1), 79-93.

⁹⁵ Commission, E. (2012). *Use of Economic Instruments and Waste Management Performances*.

⁹⁶ City of Ekurhuleni. (2024). Tariffs: Waste Management Services and Incidental Charges.

Cities in developing countries therefore need to consider whether they have the municipal administrative infrastructure in place to deliver this more complex service. The case studies below highlight how some cities are delivering PAYT related schemes with limited resources.

Case study 9: PAYT through bins in Bo City, Sierra Leone⁹⁷

Bo City is one of the leading financial, educational, and commercial centres of Sierra Leone. Like many urban centres, it struggled with waste management, with strains from increasing population and new firms starting in the city. As a result, over 30% of the city's budget was going toward waste management. Still, Bo City had difficulty managing the 120 tonnes of waste generated daily.

SIZES AND SCHEDULES			BIN OPTIONS	
SMALL (65 LITRES)			  Basket Rubber	
Collection Frequency	Monthly service fee	Weekly service fee		
1x per week	LE 6,500	LE 1,600		
3x per week	LE 19,500	LE 4,600		
Daily (Mon-Sat)	LE 29,000	LE 6,800		
MEDIUM (100 LITRES)			KLIN BO CAN PROVIDE YOU WITH HALF-DRUM BINS!	
Collection Frequency	Monthly service fee	Weekly service fee	HALF DRUM: 50,000 Le (One-Time Payment) OR 4,500 Le (Monthly)*   Half-drum Rubber	
1x per week	LE 12,000	LE 2,800		
3x per week	LE 29,000	LE 6,800		
Daily (Mon-Sat)	LE 55,000	LE 12,800		
LARGE (200 LITRES)			KLIN BO CAN PROVIDE YOU WITH FULL-DRUM BINS!	
Collection Frequency	Monthly service fee	Weekly service fee	FULL DRUM: 100,000 Le (One-Time Payment) OR 9,500 Le (Monthly)*  Full-Drum	
1x per week	LE 22,000	LE 5,200		
3x per week	LE 55,000	LE 12,800		
Daily (Mon-Sat)	LE 105,000	LE 24,500		
OTHER SIZES AND SERVICES ARE NEGOTIABLE!			* After you rent for 12 months, you owe the container. Or use your own container approved by Klin Bo.	

With private and third sector partners, the city implemented a process of door-to-door collection provided by youth groups. The schedule took principles of PAYT, as highlighted by the above pricing list. This encouraged citizens to internalise the cost of their waste generation. Since citizens were not used to paying for this service, sensitisation was critical for long-term success. The results showed an increased willingness to pay for improved waste services, increasing cost recovery, and no mention of increased informal disposal. Further spillover benefits included creating youth employment, with the initial phase of door-to-door collection creating 60 jobs.

⁹⁷ Wilson, D. C. (2015). *Global waste management outlook*. International Solid Waste Association, Issue.

Case study 10: PAYT through pre-paid stickers in Bayawan, Philippines.⁹⁸

Bayawan introduced a PAYT system through a pre-paid stickers system. This system required households to purchase one sticker per 25 litre bin bag for collecting inorganic waste. The stickers are only sold at City Hall or separate authorised sales points in markets or municipal centres. Their cost was two pesos, or USD 0.04, and each sticker comprises of two matching identification numbers. The waste collectors check the correct use of the first number and takes the second for documentation by the City Office.

The system was seemingly effective in reducing the amount of waste disposal and collection. There was no evidence that citizens switched to dumping illegally—indeed Bayawan is known as one of the cleanest in the country. There are likely two drivers: reduced waste production and increased recyclable waste given to recyclers. With the latter, recycled materials in waste sent for disposal decreased from 14% in 2003 to only 1% in 2010.

Sellable materials are now either segregated at source or delivered to local recyclers instead of ending up in landfills. In addition to this inorganic waste sticker system, households without space for composting were also given bio-waste bags and stickers. Currently, the income from the sticker system only reaches 3.5% of SWM expenditures. Therefore the fees per sticker could be made higher, or amount of weight per collection bag lower, to increase cost recovery. However, as throughout waste collection, the balance between compliance and willingness to pay is crucial.

Non-household charges

Household tariffs are only half the picture. Commercial and construction waste drive volumes and require targeted pricing at the point of disposal and proof of contracted service. Business users typically have higher and more predictable volumes, allowing stronger cost-reflective pricing with lower evasion risk.

The role of landfill taxes

Landfill taxes or gate fees are the fees charged to waste collectors, transporters or final disposers at the landfill site. Where there is strong compliance, this directly incentivises the reduction or prevention of waste. However, in areas with lower levels of compliance, high gate fees can incentivise informal dumping. Ideally, the fee should match the real cost to society of putting waste in a landfill — including the long-term environmental and health impacts.

⁹⁸ Ing, J.-P. (2012). Economic Instruments for Solid Waste Management: Case Study Bayawan, Philippines. GIZ.

In Mozambique and Ghana, both private operators and individuals must register their trucks for a fee and subsequently pay the municipality to use the weighbridge at the final disposal site.⁹⁹ This policy contrasts with approaches from Kampala, Uganda and its peri-urban areas in Wakiso district, where waste is disposed at the Kiteezi landfill free of charge.¹⁰⁰ Such zero gate fees protect compliance where enforcement is weak, and dull diversion incentives.

Gate fees can vary depending on waste type, its cost, and benefits derived from the waste. For example, it can be lower for segregated waste, thus incentivising segregation. In OECD countries, there is a correlation between high landfill taxes and lower landfill rates.¹⁰¹ However, without efforts towards raising public awareness and capacity to enforce, just changing gate fees in developing countries may just lead to increase street dumping. For example in Ghana, the Aboboyaa operators choose informal dump sites not only avoid the high fees at landfill sites, but also the long queues.

The role of proof of service

Proof of service refers to the municipality issuing a requirement for documentation or verification of collection process at commercial or business-level, with an associated fee. This is done to ensure non-household waste generators are paying and included in the tax system. Typically, details such as collection frequency, types of waste collected, and the SWM collectors' compliance with local regulation are included.

Some of Mozambique's cities included such a proof of service, launching the licensing and registration system in 2006.¹⁰² All large-scale non-households generating high quantities of waste—more than 25kg—should require the services of private operators or the municipal authority to collect the waste. The related fee is charged according to daily waste generation. Only three municipalities have implemented this commercial waste fee system, and those struggle with enforcement as there is no solution for those unwilling to pay.¹⁰³

99 Stretz, J. (2012). Economic instruments in solid waste management. GIZ.

100 Aryampa, S., Maheshwari, B., Sabiiti, E., Bateganya, N. L., & Bukenya, B. (2019). Status of Waste Management in the East African Cities: Understanding the Drivers of Waste Generation, Collection and Disposal and Their Impacts on Kampala City's Sustainability. *Sustainability*, 11(19), 5523.

101 OECD. (2019). *Countries with high landfill taxes tend to have lower landfill rates*.

102 Ferrão DAG (2006) *An Examination Of Solid Waste Collection And Disposal In Maputo City, Mozambique*. University of Cape Town, Cape Town.

103 Ferrari K, Gamberini R, Rimini B (2016) The waste hierarchy: a strategic, tactical and operational approach for developing countries: the case study of Mozambique. *Int J Sustainable Dev Plan* 11: 759-770.

Contrastingly, in Nepal, proof of service with payment conditional on achieving predetermined results (such as increasing source separation and increase fee collection) greatly increased service quality.¹⁰⁴ Because waste streams and capacities change, tariff design cannot be static; it needs predictable adjustment rules.

Adapting the fee structure to local characteristics

Effective waste disposal strategies must also be adaptable as and when the situation demands it. For instance, Sweden introduced a landfill tax in 2000 to reduce the amount of waste that was coming to landfill, and then later on in 2005, decided to fully ban combustible and organic wastes from landfills. Thus, over time, the shift in the waste disposal pattern to incineration and recycling was encouraged by the government.¹⁰⁵ The government consciously made these decisions considering the changing waste situation and country priorities. Here, a dynamic, locally relevant, economically feasible, operationally simple waste management system yields noteworthy results. This requires municipalities to be able to adjust and adapt their management systems in line with local needs and enforcement capacity, willingness to pay, changing environmental objectives, and national-level priorities.



104 Banna, F. M., Bhada-Tata, P., Ho, R., Kaza, S., & Lee, M. (2014). Results-based financing for municipal solid waste. *Main Report (English) in Urban Development Series Knowledge*, 2, 1-84.

105 Wilson, D. C. (2015). *Global waste management outlook*, International Solid Waste Association, Issue.

5. Conclusion

Solid waste management is an urgent, system-wide task as developing cities grow. Volumes are rising, the composition is harder to manage, and the costs of failure—for health, climate, and infrastructure—are high. It is also a visible test of municipal competence.

This paper highlights key considerations for city leaders:

- 1. Optimise access, cost efficiency, and reliability.** Household or communal storage needs to be close enough to minimise walking distance, yet large enough—and supported by transfer stations—to lower transport costs. Predictable timetables improve household compliance but require operational discipline.
- 2. Retain value where markets allow, but dispose safely where they do not.** Segregation at source and reliable pick-up raise the quantity and price of recyclables. Where markets are thin, sanitary disposal and emissions control need to be prioritised.
- 3. Match provider to task, and integrate informal capacity.** Trunk collection and disposal require public coordination. Outsourcing or public–private partnerships can add capability where risks and performance are contractible, but need to be monitored and regulated. Recognising and equipping informal collectors expands coverage and recovery at low fiscal cost.
- 4. Make compliance the easy choice.** Deterrence rests on the likelihood of enforcement, not simply the value of the fine. Awareness campaigns can address information gaps, and visible service builds trust. Simple, transparent rules limit discretion and bribery.
- 5. Price with a two-part logic and protect the poor.** Cover fixed network costs with a modest fixed charge; add a variable element where enforcement is credible. Where capacity is low, start with existing taxes or flat fees to avoid pushing households to dump. Use rebates to safeguard low-income users.

Finally, sequencing matters. Municipalities' SWM systems should evolve to align with local needs and enforcement capacity, willingness to pay, changing environmental objectives, and national-level priorities.

6. Further reading

1. Kaza, S., Yao, L., Perinaz Bhada-Tata, Frank Van Woerden, (2018). What a Waste: An Updated Look into the Future of Solid Waste Management. World Bank.
2. Folz, D.H., Giles, J.N., (2002). Municipal Experience with "Pay-as-You-Throw" Policies: Findings from a National Survey. *State and Local Government Review* 34, 105–115.
3. Wilson, D.C., Velis, C., Cheeseman, C., (2006). Role of informal sector recycling in waste management in developing countries. *Habitat International, Solid Waste Management as if People Matter* 30, 797–808.
4. Coffey, M., Coad, & A., (2010). Collection of municipal solid waste in developing countries. United Nations Human Settlements Programme.
5. Stretz, J. (2012). Economic instruments in solid waste management. GIZ

Appendix 1: Waste diversion and disposal

	Open Burning	Landfill (open)	Landfill (semi-controlled)	Landfill (sanitary)
Definition	Burning of waste at low temperatures	Designated locations where waste is disposed of without health, safety, or environmental provisions.	Designated locations where waste is disposed of with some environmental management, e.g covered with a top layer of soil.	Designated locations for waste disposal that are scientifically designed to treat ground seepage.
Overview	Open burning is a low-cost solution and can quickly reduce odour from organic waste, but emits pollutants into the air. It is commonly used in lower-income neighbourhoods, who bear the brunt of the health impacts.	As a cost-effective and simple solution, approximately 40% of waste in the world ends up in open landfills, with this practice particularly frequent in developing countries. By leaving waste open to the local ecosystem, open landfills have severe impacts on the environment and public health. ¹⁰⁶	By compacting and covering waste with a layer of soil, semi-controlled landfills limit some of the odours and hygiene problems of unregulated landfills. However, they are not designed to reduce leachate discharges and gas emissions.	Sanitary landfills help maintain health, safety, and environmental protection procedures by intercepting leachate and controlling gas emissions. This allows cities to continue to dispose of waste away from its population while limiting health and ecosystem impacts.
Environmental considerations	✗ Global climate consequences—releases black carbon, a large and often overlooked contributor to global warming. ✗ Local warming—black carbon absorbs sunlight, heating local ecosystems.	✗ Contamination — Unsanitary landfills can lead to air and groundwater pollution. ✗ Disposal area — Open landfills require large areas away from residential zones. This may cause additional air pollution with numerous trucks travelling to landfills daily. ✗ Decomposition—Organic material in the landfill decomposes to release methane, which is highly combustible and contributes to local emissions.¹⁰⁷	✓ Air pollution is reduced with the top layer of soil. ✗ Groundwater contamination — If semi-controlled landfills do not use liners, groundwater pollution still occurs. ✗ Disposal area — Semi-controlled landfills require large areas away from residential zones. This may cause additional air pollution with numerous trucks travelling to landfills daily. ✗ Decomposition—Organic material in the landfill decomposes to release methane, which is highly combustible and dangerous and contributes to local emissions.¹⁰⁸	✓ Contamination — Liners and treatment procedures ensure that toxins do not leach into groundwater or pollute the air.¹⁰⁹ ✓ Decomposition — Sanitary landfills control gas emissions linked to decomposition, limiting safety risks and local pollution. ✗ Disposal area — Sanitary landfills still require large zones from residential areas, continuing to contribute to pollution via trucks travelling to the site.¹¹⁰

106 NEP. Open dumping. <https://www.unep.org/topics/chemicals-and-pollution-action/waste/open-dumping>

107 Kocasoy, G., & Curi, K. (1995). The Ümraniye-Hekimbaşı open dump accident. *Waste Management & Research*, 13(4), 305-314.

108 Ibid.

109 MIT. (n.d). *What is a Sanitary Landfill?*

110 Narayana, T. (2009). Municipal solid waste management in India: From waste disposal to recovery of resources? *Waste Management*, 29(3), 1163-1166.

	Open Burning	Landfill (open)	Landfill (semi-controlled)	Landfill (sanitary)
Economic considerations	Costs: Lowest direct public cost, highest social cost (health, climate, clean-up). Jobs: Negligible formal job creation; some unsafe informal activity. Low skill. Markets: None (no value retention; undermines recycling/composting).	Costs: Low capex/opex now, high future liabilities (remediation, closures). Jobs: Low formal job intensity; informal picking common but unsafe. Low skill. Markets: Weak; possible gate fees if charged; informal sale of recyclables.	Costs: Low–moderate capex/opex (cover, basic compaction). Lower nuisance costs than open dumps. Jobs: Low–moderate; site operations, basic equipment. Low–mid skill. Markets: Limited; gate fees feasible; future potential for gas capture if upgraded.	Costs: High capex, moderate–high opex (liners, leachate, gas systems); longer asset life lowers future capex. Jobs: Moderate; ongoing O&M, compliance. Mid skill. Markets: Gate fees; landfill gas-to-energy and possible carbon credits add revenue; value retention still limited versus diversion.
Health impacts	✗ Releases toxins—open burning leads to the uncontrolled release of contaminants into the air, land, and groundwater through ash and smoke.¹¹¹ These have a disproportionate impact on the health of the urban poor.	✗ Disease — Poorly managed landfills can carry infectious diseases and release methane into the local atmosphere.¹¹² ✗ Workplace risks — Formal and informal workers on landfill sites experience heightened exposure to health diseases. ✗ Dangerous waste — If waste is unsegregated, medical and hazardous waste may also end up in open dumpsites.	✓ Disease — Burying compacted waste helps limit odours and pests drawn to landfills, thus limiting litter, animal nuisances, and the possibility of contamination when compared to open landfills.¹¹³ ✗ Workplace risks — A lack of waste segregation in semi-controlled landfills still exposes formal and informal workers to health risks.	✓ Disease — Sanitary landfills mitigate the health impacts of landfills by implementing hygienic and sanitation procedures, preventing the spread of disease or emissions.¹¹⁴ ✓ Workplace risks — Creating proper waste disposal facilities, where dangerous emissions and health risks are controlled, can help protect both formal and informal workers present at sanitary landfills.
Municipal capacity	✓ Low fiscal capacity—Little or no municipal capacity needed, since most open burning takes place at individual level.¹¹⁵ ✓ No cost of collection and disposal.	✓ Easy implementation — Low maintenance and cost compared to other disposal methods. ✓ Does not require high levels of segregation. ✓ Affordable — On average \$25 per tonne for collection and disposal.	✓ Does not require high levels of segregation. ✗ Higher fiscal capacity — Requires greater investment than open landfills with heavy machinery, linings, and more workers needed to bury waste.	✓ Does not require high levels of segregation. ✗ High fiscal capacity — Requires higher municipal investment, resources, and capacity to successfully segregate and control waste. Designing sanitary landfills also requires evaluations of topography, geography, safety, and natural resources, needing a high level of government engagement.

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115 Vidanaarachchi, C. K., Yuen, S. T. S., & Pilapitiya, S. (2006). Municipal solid waste management in the Southern Province of Sri Lanka: Problems, issues and challenges. *Waste Management*, 26(8), 920–930.

	Waste to energy: controlled incineration	Waste to energy: biogas and biofuel	Composting	Recycling
Definition	Combustion of waste under controlled conditions at a high temperature.	Production of biogas from decomposing organic materials.	Controlled decomposition of organic waste.	Disposal of inorganic and recyclable solid waste items like plastic, metal, and tin to be reused or remanufactured.
Overview	Controlled incineration can be highly efficient, able to process around 1000 tonnes of waste per day. ¹¹⁶ It can also be an energy source, displacing fossil fuels.	Biogas and biofuel generate fuel for electricity, heating, transportation, or fertiliser, thus potentially displacing fossil fuels as energy sources. It is also compatible with high organic waste outputs, as are typically found in developing country cities.	Composting is an appropriate disposal method for developing countries as organic waste makes up the majority of waste output. Composting has a limited record of large-scale operation in Africa and Latin America, with Asian developing countries having the best records and suitability for composting.	Recycling is an environmentally friendly disposal mechanism that facilitates the reuse of resources. Recycling policies and implementation can be integrated into existing practices, working well with informal waste collection with municipal supervision. However, for recycling to be viable, materials need to be designed to be recyclable, and many are currently not.
Environmental considerations	✗ Super pollutants—incineration can release pollutants through residue, slag, and fly ash.¹¹⁷ Municipalities need regulations to ensure emission and environmental controls.¹¹⁸ ✗ Incineration may reduce incentives to recycle and reuse.	✓ Low emissions — reduces the emissions of natural decomposition and reduces pollution when compared to incineration.	✓ Sustainable — Environmentally and eco-friendly, resulting in low air and water pollution.¹¹⁹ ✗ Pollution — Methane is released, with potential odours affecting air quality, and leachate can impact water without the correct infrastructure.	✓ Landfill reduction — recycling promotes sustainability in waste management by reducing disposal via landfill. ✗ Pollution — Informal recycling can lead to air, soil and water pollution from hazardous materials, such as e-waste or chemicals.
Economic considerations	Costs: Highest capex/opex; cost per tonne high; sensitive to feedstock quality. Jobs: Low–moderate per tonne, high skill (engineering, controls); maintenance intensive. Markets: Power/heat agreements + gate fees; ash disposal cost; risk of crowding out recycling if plants are feedstock-hungry.	Costs: Moderate capex/opex; requires segregated organics and reliable throughput. Jobs: Moderate; collection of organics, plant O&M. Mid skill. Markets: Electricity/heat/CNG + digestate/fertiliser; gate fees possible; offtake/price risk for energy products.	Costs: Low–moderate capex, low opex if feedstock is clean; unit costs rise with contamination. Jobs: High labour intensity per tonne; low–mid skill; suitable for MSMEs and community operations. Markets: Compost sales (often low price/seasonal demand), plus gate fees; quality assurance key to uptake.	Costs: Variable with collection capex moderate–high; opex moderate; depending on segregation and contamination rates. Jobs: High across collection/sorting; scope for formalising informal pickers. Low–mid skill with specialist roles in processing. Markets: Strong but volatile; revenues tied to commodity prices and specifications.
Health impacts	✗ Toxin release — Plants that do not reach health standards can release heavy metals, dioxins, and other compounds into the air.	✓ Overall safer than other methods, but biological decomposition can release substances that impact worker health.	✓ Overall safer than other methods, but biological decomposition can release substances that impact worker health	✓ If supported by informal pickers, e-waste and dangerous recyclables can have an impact on worker health.

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	Waste to energy: controlled incineration	Waste to energy: biogas and biofuel	Composting	Recycling
Municipal capacity	✗ Expertise – requires highly skilled personnel and specific maintenance, which may not be available within municipalities. ✗ High levels of coordination – Requires collaboration with electricity providers to recover installation costs and integrate with local grids. ✗ High fiscal capacity—investment and operating cost per tonne four times higher than recycling. Incineration and waste to energy are among the most expensive waste disposal options, estimated as US 82,000 per tonne in a study of plants across Asia.¹²⁰	✗ High fiscal capacity—Requires larger and more comprehensive machinery than composting, but much cheaper than incineration. ✗ Expertise—needs experts to install and maintain biogas technology.	✗ High compliance—composting requires citizen engagement to ensure waste segregation.¹²¹ ✗ Timely supply chains—waste must be disposed of on time. ✗ Lower efficiency—composting processes less waste (about 250 tonnes) per day than other methods, such as incineration ✓ Lower fiscal capacity needed — Composting requires a relatively low initial investment, depending on the plant designs.¹²²	✗ High fiscal capacity—recycling plants can be expensive to run, depending on the recycling technology used.¹²³ ✗ More expensive than landfill ✗ Requires segregation at source.

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